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THERMAL ANALYSIS AND FOOD QUALITY
The possibility to qualify the pasta processing

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Thermogravimetry (TG) and derivative thermogravimetry (DTG) are proposed as a fast and sensitive tool to discriminate the industrial processing of spaghetti pasta by focusing the attention on the thermal profiles of the structured water release. Thirteen different name-brand and store-brand kinds of spaghetti pasta were analysed. The results show different profiles according to the drying procedures. By on-line coupling a FTIR spectrometer to the thermobalance, the evolved gas analysis (EGA) allowed to confirm the water releasing step.

Keywords: *coupled TG-FTIR, EGA, food quality, pasta, processing, spaghetti, TG*

Introduction

Fast and sensitive methodologies of food analysis, especially for industrial purposes, are useful tools to determine the quality of final commercial products. Moreover, the possibility to use always easier tools to analyse the authenticity of the certificated food is a daily challenge.

Thermal analysis is recognized as an instrumental method of food analysis able to give unique information regarding the nature of the sample or the modifications induced by industrial processing. Books and reviews report the applications of thermoanalytical techniques to the food science [1–6].

Moreover, thermal analysis combined with evolved gas analysis techniques (EGA) allows the optimisation of heating treatments as well as the recognition of alterations, caused by the heat during evaporation of water (to be avoided as much as possible in the field of pasta processing) [7–9].

A multiparametric investigation by our group is in progress to determine the quality of pasta samples and to distinguish between high temperature and low temperature dried pasta. This very important aspect is in fact strictly related to the more rapid industrial production but also to the possible decrease of the final product quality because of the loss of nutrients (i.e. proteins) which is more important at high temperatures.

The results of this work allow to propose thermogravimetry (TG) and derivative thermogravimetry (DTG) as fast and sensitive tools to discriminate the industrial processing of spaghetti pasta. This is possible by focusing the attention on the different thermal profiles of the structured water release, as shown by our results.

Evolved gas analysis (EGA), obtained by on-line coupling a FTIR spectrometer to the thermobalance, demonstrated the water release and allowed to exclude any other decomposition processes.

Experimental

Pasta sampling

Thirteen different name-brand and store-brand kinds of spaghetti pasta were purchased in several stores and labelled with letters ranging from A to N. Small segments from the central portion of the spaghetti pasta were collected and analyzed without any treatment.

Reproducibility was tested by the analysis of at least three segments from three different spaghetti of each brand.

Instrumental

The thermoanalytical curves were obtained by using a Perkin Elmer TGA7 thermobalance (range 20–1000°C); the atmosphere was either pure nitrogen or air, at a flow rate of 100 mL min^{-1}; the heating rate was varied

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between 5 and 40°C min^{-1}, with the best resolution achieved at a scanning rate of 10°C min^{-1}. Reference cell is empty.

To obtain the IR spectra of the vapours or gases evolved during the thermogravimetric analysis, the thermobalance was coupled to a Perkin Elmer FTIR spectrometer, model 1760X. The TGA7 is linked to the heated gas cell of the FTIR instrument by means of a heated transfer line, the temperatures of the cell and of the transfer line being independently selected.

Results and discussion

The TG curves of the thirteen analyzed store-brand and name-brand spaghetti pasta samples are reported in the Fig. 1a. Two interesting temperature ranges can be noticed, where the samples show different thermal profiles: 180–230 and 480–750°C.

Our interest focuses in the temperature range 180–230°C (expanded scale, Fig. 1b), where the water release shows characteristic differences. While the mass loss is a non-discriminating factor because of the absence of clear systematic differences, the first derivative curves, reported in the Fig. 2 (expanded scale), show at least three different behaviours. The maxima of the DTG curves can be found in three temperature ranges: *i*) below 200°C; *ii*) between 200 and 207°C; *iii*) over 207°C.

The available information about the drying conditions in the industrial production of 8 samples (A, C, D, E, F, J, K and L) allows the temperatures of the DTG maximums to be reliably used to state whether the process occurred at high (about 90–95°C) or low (about 50°C) temperature. More specifically,

- all the samples dried at high temperatures have a DTG maximum below 200°C (A, C and D);
- all the samples dried at low temperatures have a DTG maximum over 200°C (E, F, J, K and L).

The differences within the second group, with five samples with DTG maximums in the range 200–207°C and four samples with DTG maximums above 207°C, are probably related to different drying temperatures and consequently, different times of exsiccation.

This statement allows one to guess the thermal history experienced by the other samples (B, G, H, M

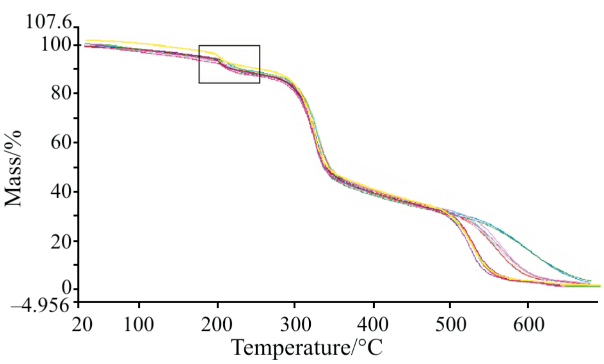

Fig. 1a TG curves of the thirteen spaghetti pasta samples, Heating rate: 10°C min^{-1}; Air flow at 100 mL min^{-1} rate

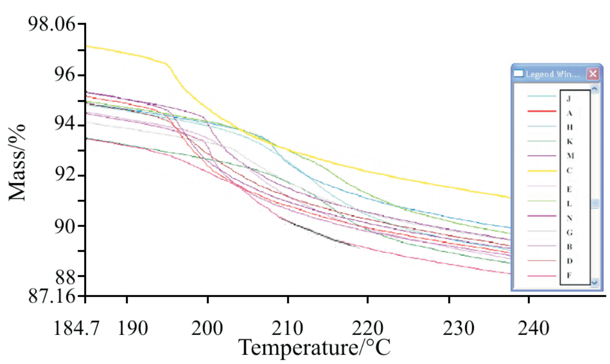

Fig. 1b TG curves (box in Fig. 1a - expanded scale around 200°C) of the thirteen spaghetti pasta samples. Heating rate: 10°C min^{-1}; Air flow at 100 mL min^{-1} rate

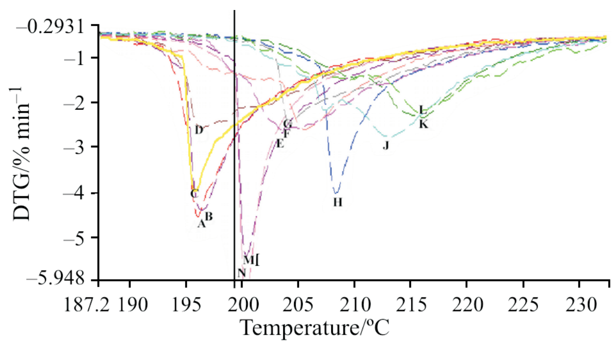

Fig. 2 DTG curves (expanded scale around 200°C) of the thirteen spaghetti pasta samples. Heating rate: 10°C min^{-1}; Air flow at 100 mL min^{-1} rate

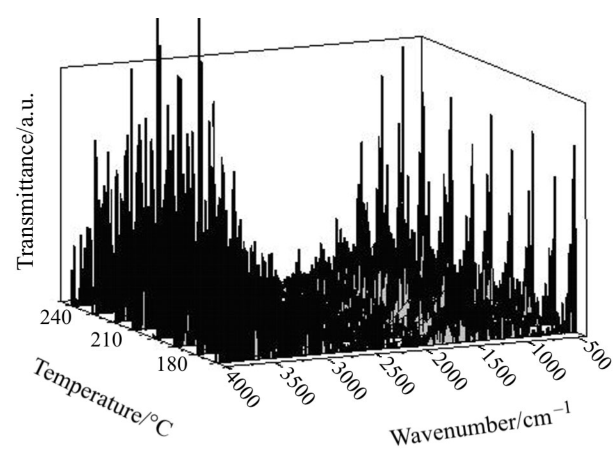

Fig. 3 Infrared spectra of the TG evolved gases in the temperature range 190–230°C; Air flow at 100 mL min^{-1} rate; Resolution: 8 cm^{-1} – 10 scans per spectrum

and N) for which no information is available about the relevant industrial drying process.

The analysis of the evolved gases (EGA), performed with an on-line FTIR spectrophotometer coupled to the thermobalance, showed (see the stacked plot of the spectra recorded in the temperature range 190–230°C in Fig. 3) IR bands that can be attributed only due to released water.

Conclusions

Thermogravimetry and derivative thermogravimetry are useful tools to check the industrial drying process of spaghetti pasta. The results show the possibility to give fast and accurate pieces of information and to propose TG and DTG for the control and the certification of the pasta quality.

References

1 'Thermal Analysis of Foods' W. R. Harwalker and C. Y. Ma Eds, Elsevier Applied Food Science Series, N.Y. 1990.
2 A. Schiraldi, L. Piazza, D. Fessas and M. Riva, Handbook of Thermal Analysis and Calorimetry, 4 (1999) 829.
3 'Food Analysis' 3rd edition S. Suzanne Nielsen Ed., Aspen Publishers (2003).
4 A. Raemy, J. Therm. Anal. Cal., 71 (2003) 273.
5 S. Vyazovkin, Anal. Chem., 76 (2004) 3299.
6 Y. Roos, Phase transition of foods, Academic Press, New York (1995).
7 S. Materazzi and R. Curini, Applied Spectroscopy Reviews, 36/1 (2001) 1.
8 S. Materazzi and R. Curini, Applied Spectroscopy Reviews, 36/2-3 (2001) 169.
9 S. Rückold, H.-D. Isengard, J. Hanss and K. H.Grobecker, Food Chem., 82 (2003) 51.